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Indian Standard

REFERENCE AMBIENT TEMPERATURE FOR ELECTRICAL EQUIPMENT

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Indian Standard

REFERENCE AMBIENT TEMPERATURE FOR ELECTRICAL EQUIPMENT

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Indian Standard

REFERENCE AMBIENT TEMPERATURE FOR ELECTRICAL EQUIPMENT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 December 1980, after the draft finalized by the Electrotechnical Standards Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The safe and reliable operation of an electrical equipment is achieved by ensuring amongst other things that under normal conditions of operation the steady state temperature of the equipment is maintained within the limits for which the electrical insulation is designed. This limit ultimately decides the safe current (rated current) which can pass through the equipment without unduly affecting the life of the insulation.

0.3 Over the period, a convention has been established to specify the permissible temperature-rise over a reference ambient temperature instead of the absolute limiting temperature of the equipment. This method provides the following two distinct advantages:

a) It avoids the need for the consumers to correctly assess the ambient temperature every time so as to ensure that under actual conditions of operation the equipment would always be operating within the safe temperature limits.

b) It eliminates the disputes about the performance data when the tests are conducted at places having different ambient conditions.

0.4 These factors therefore, make it necessary to define suitably a standard reference ambient temperature. It is also necessary to mention the basis for arriving at the standard reference ambient temperature, so that the designer of the equipment is well aware of all its implications.

0.5 It is observed that different specifications in the electrotechnical field have used, in many cases, different terminologies for defining the term standard reference ambient temperature. The emphasis that is to be laid on daily peak temperature, daily average temperature and yearly average temperature while computing reference ambient temperature has not been clearly brought out. This standard would therefore serve as a guide in this regard ensuring correct reference to the term with all its implications.

0.6 It is not intended that the standard reference ambient temperature given in this specification is to be uniformly adopted for all electrical equipment. However, this standard would enable the various Committees to start with a common terminology and make departures only where absolutely necessary and unavoidable. It is recommended that the reasons for departures, when made, shall be indicated in the individual specifications to enable the peculiarities of the equipment and the conditions of its use to be better understood.

0.7 This standard recognizes the fact that in quite a few specific applications, when the ambient conditions are more severe than the specified standard ambient conditions, the equipment would need derating keeping in view the margin of safety envisaged. This standard does not cover the criteria and the methods of derating. This standard; however, includes the criteria for calculating the reference ambient temperature when the equipment is to be used under ambient conditions different from those indicated as standard. This, it is hoped, would guide the application engineer to decide whether a derating is required or not.

0.8 This standard is intended for equipment for common application, where natural air cooling is employed. Special installation conditions and proximity of other equipment delivering their own heat are not covered where special precautions may be necessary.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2 - 1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the standard ambient conditions of temperature for the use of electrical equipment.

1.2 This standard also specifies the standard reference ambient temperature for ratings of electrical equipment.

1.3 This standard also lays down guidance for calculating reference ambient temperature when the equipment is to be used under conditions different from those presumed for the purposes of this standard.

---

*Rules for rounding off numerical values (*revised*).

2. STANDARD AMBIENT CONDITION OF TEMPERATURE FOR ELECTRICAL EQUIPMENT

2.1 Unless otherwise specifically stated, electrical equipment shall be suitable for use under the following standard ambient temperature condition:

a) Maximum ambient air temperature not exceeding	45°C
b) Maximum daily average ambient air temperature not exceeding	35°C
c) Maximum yearly average ambient air temperature not exceeding	30°C

2.2 The basic assumptions made in deciding the standard ambient conditions of temperature are given in Appendix A.

3. STANDARD REFERENCE AMBIENT TEMPERATURE

3.1 Electrical equipment shall normally be rated to be used at a standard reference ambient of 40°C.

NOTE 1 — Temperature rise limits shall normally be specified over the standard reference ambient temperature given above (*see also* **0.6**).

NOTE 2 — The value of 40°C as standard reference ambient temperature represents an equivalent condition which is about 10°C more severe than the standard ambient conditions of temperature stipulated in **2.1** (*see* Appendix B).

4. CALCULATION OF REFERENCE AMBIENT TEMPERATURE

4.1 In case one or more temperatures under conditions of use differ appreciably from the values given in **2.1**, the reference ambient temperature would have to be recalculated.

4.2 Reference ambient temperature in such cases would be

$$= \frac{1}{3} \text{(Maximum ambient air temperature + maximum daily average air temperature + maximum yearly average air temperature + 10)}$$

all values being in °C.

NOTE — The formula given above provides for a desired margin of safety (*see* **B-2**) over the weighted ambient temperature.

APPENDIX A

(*Clauses* 2.2 *and* B-1)

BASIC ASSUMPTIONS IN DECIDING STANDARD AMBIENT CONDITIONS OF TEMPERATURE

A-0. The details given below explaining the basic assumptions, made in deciding the standard ambient conditions of temperature are provided by the Indian Meteorological Department, based on the study done by them.

A-1. Collection and study of the basic data on the actual service conditions in India were initiated quite some time ago. A detailed study of the climatic conditions prevailing in the country over several years was made from the graphs, maps and tables published by the Indian Meteorological Department, and the various journals and books on the subject.

A-2. The factors from which the reference ambient temperature is derived are the following:

a) Maximum ambient air temperature,

b) Maximum daily average ambient air temperature, and

c) Maximum yearly average ambient air temperature.

A-2.1 Maximum Ambient Air Temperature

A-2.1.1 The criteria for chosing the maximum ambient air temperature are:

i) it should be reached for and persisted for not more than a few hours every day and for a few days in the hottest seasons; and

ii) it should be substantially exceeded for not more than a few days in a year.

A-2.1.2 It has been found from the records of the Indian Meteorological Department and from the isotherms of daily maximum temperature that the country is covered by two zones of temperatures, namely 40°C and 45°C during the month of May. During June, the temperature averages around 40°C. The duration of temperatures in the region of 40°C is very short and will form only a fraction of the total time. It is also observed that for representative locations in the country 40°C is not exceeded for more than 1 percent of the time. Hence, the selection of 45°C as the maximum ambient air temperature.

A-2.2 Maximum Daily Average Ambient Air Temperature

A-2.2.1 The daily average ambient air temperature is taken to be the mean of the maximum, and minimum daily temperatures for the hottest month.

A-2.2.2 From the isotherms of average daily temperatures for the months of April, May, June and July, it is seen that there is a small stretch in month of May where the temperature exceeds 35°C. In all the other months the daily average air temperature is 35°C or below throughout the country. Hence the selection of 35°C as the daily average ambient air temperature.

A-2.3 Maximum Yearly Average Ambient Air Temperature

A-2.3.1 The average value of the yearly ambient air temperature in the country varies from 24°C to 28°C as seen from the isotherms of annual average temperature. There are two small periods where the value of 28°C is exceeded. 30°C as the yearly average ambient air temperature has been specified, taking into account even an extreme case where the yearly average may touch this temperature.

APPENDIX B

(*Clause* 3.1)

EXPLANATORY NOTES ON THE FORMULA FOR REFERENCE AMBIENT TEMPERATURE FOR ELECTRICAL EQUIPMENT

B-1. As far as the thermal factor on ageing of insulation is concerned, the value of 40°C as standard reference ambient temperature (*see* **3.1**) represents an equivalent condition which is about 10°C more severe than the standard ambient conditions; stpiulated in clause **2.1**. This can be shown as enumerated in the following manner.

B-1.1 It is possible to calculate an 'equivalent' which the equipment can be continuously subjected to, to give the same life, by assuming the following:

a) *Assuming the following conditions of use:*

45°C for 1 percent of the time (that is 87·6 hours in the year)
35°C for 33 percent of the time (that is 4 months in the year)
30°C for 33 percent of the time
25°C for 33 percent of the time

b) *Assuming* operation of the equipment for 1 percent of the time at Q_p, 33 percent of the time at Q_d, 33 percent of the time at Q_y, and 33 percent of the time at (Q_y —5°C); and

c) *Assuming* that insulation life is halved for every K°C increase of ambient temperature.

Table 1 below gives, 'equivalent' values calculated for different values of ambient conditions and values of K.

TABLE 1 WEIGHTED AMBIENT TEMPERATURE (QW) GIVING SAME LIFE AS ASSUMED AMBIENT CONDITIONS AND REFERENCE TEMPERATURE

(*Clauses* B-1.1 *and* B-2)

AMBIENT CONDITIONS HALF LIFE FACTOR K	$Q_y = 30°C$ $Q_d = 35°C$ $Q_p = 45°C$	$Q_y = 30°C$ $Q_d = 35°C$ $Q_p = 55°C$	$Q_y = 30°C$ $Q_d = 40°C$ $Q_p = 45°C$	$Q_y = 34°C$ $Q_d = 35°C$ $Q_p = 45°C$	$Q_y = 35°C$ $Q_d = 40°C$ $Q_p = 55°C$
(1)	(2)	(3)	(4)	(5)	(6)
5	31·5°C	32·8°C	34·3°C	34·3°C	37°C
10	30·7°C	31·2°C	32·1°C	34·15°C	36·1°C
15	30·5°C	31°C	31·9°C	33·95°C	35·85°C
FORMULA 1/3 ($Q_y + Q_d + Q_p + 10$)	40°C	43·3°C	41·66°C	41·33°C	46·66°C

where

Q_y = maximum yearly average ambient air temperature,

Q_d = maximum daily average ambient air temperature,

Q_p = maximum ambient air temperature,

Q_w = weighted ambient temperature, and

K = the change in temperature in °C required to half the life.

NOTE — Weighted ambient temperatures shown above are calculated using the formula given below:

$$1\,e\left[\frac{\log_e 2}{K}(Q_p - Q_w)\right] + 33\,e\left[\frac{\log_e 2}{K}(Q_d - Q_w)\right]$$

$$+ 33\,e\left[\frac{\log_e 2}{K}(Q_y - Q_w)\right] + 33\,e\left[\frac{\log_e 2}{K}(2\,Q_y - Q_d - Q_w)\right] = 100.$$

B-2. It can also be seen from Table 1 that the reference ambient temperature calculated using the formula in **4.2** provides a desired margin of safety in rating of electrical equipment.